Exp. # 1

Deflection of Beams
(Simply supported & cantilever)

Objective:

To investigate the support reaction forces and deflection of a simply supported beam and a cantilever beam.

Theory:

Simply Supported Beam.

Figure 1 shows a simply supported beam of length L, (A, B) are the reaction forces and F is a concentrated force acting at distance x from A. The reaction forces A & B are calculated using equilibrium equations:

$$\sum M_B = 0 \text{ , and } \sum M_A = 0$$

Solving for support forces A & B, as in figure 1 we get:

$$A = F(1 - \frac{x}{L}) \text{ , } B = F.\frac{x}{L}$$

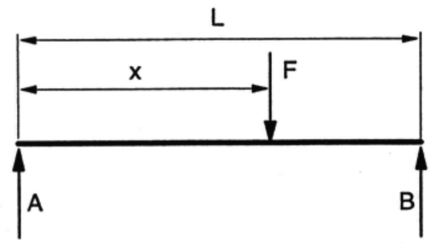


Figure 1: Supporting forces on the bar

The equation for the elastic line of a bar loaded in the center with the single force is as follows for the section between the left-hand support and the load with $0 \le x \le L/2$

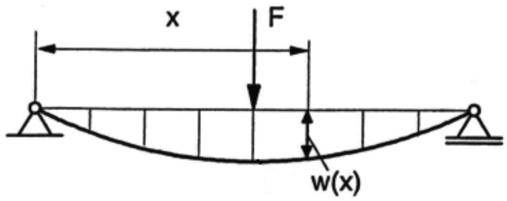


Figure 2: Bar on two supports.

$$w(x) = \frac{FL^3}{48EI}\left[3\frac{x}{L} - 4\frac{x^3}{L^3}\right]$$

The section between the load and the right-hand support is symmetrical to this. The maximum deflection is at the center of the bar

Where x = L/2 directly beneath the load.

$$w_{L/2} = \frac{FL^3}{48EI}$$

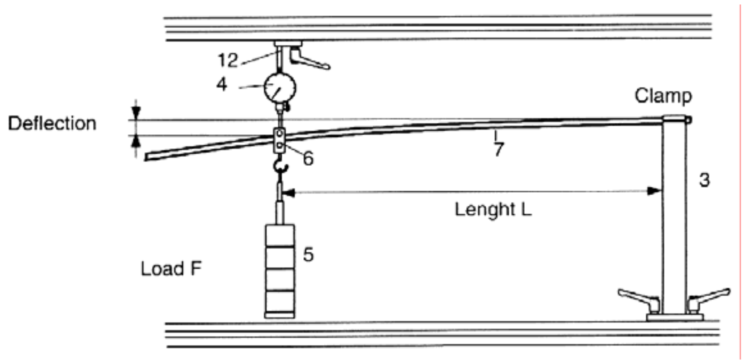


Figure 3: Deflection of cantilever beam

In a cantilever bar, one side of the bar is fixed and the other side free.

The equation for the deflection y of the bar at the point of application of force is

$$Deflection\,(y) = \frac{FL^3}{3EI}$$

Deflection is proportional to the load F and the cubed length of the bar; inversely proportional to the modulus of elasticity E and area moment of inertia I_y.

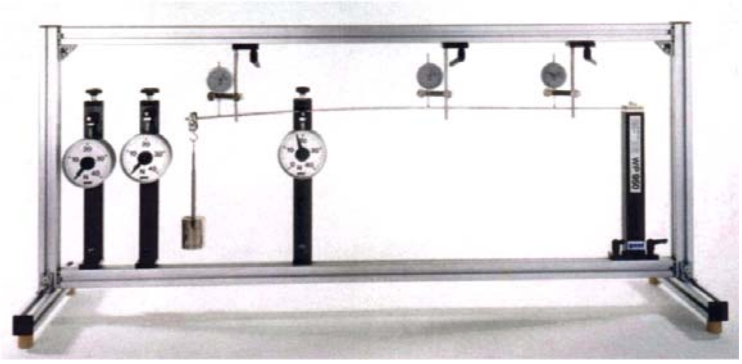
The influence of the Length L at the deflection should be demonstrated in this experiment.

For this purpose, the force should be constant. The experimental bar is made of steel (modulus of elasticity E = 210000 N/mm^2) and has a cross-section of b x h mm.

$$Area\ moment\ of\ Inertia\ (I) = \frac{bh^3}{12}$$

Apparatus & Equipment Needed:

The table unit consists of a strong aluminum section frame. Beam specimens of varying thickness made of different materials. Loading is applied using sets of weights and the beam deformation measured using measurement gauges. The forces are determined using dynamometers integrated into the bearings. The height of the measurement gauges in their holders is adjustable. Like the figure below.



Procedure:

Part 1:

Measurement of the reaction forces:

1. Fasten the articulated supports at a distance of 1000mm.
2. Push the rider for the weight suspender onto the bar and place the bar on the supports.
3. Loosen the looking screw on the support. Adjust the height of the support using the rotary knob until the bar is horizontal. Re-secure the support using the locking screw.
4. Set the scale on the dynamometer to zero by twisting.
5. Suspend the weight of and load the bar.
6. Read the supporting forces on the dynamometer and record.

Part 2:

Deflection of simply supported beam:

1. The load remains constant and is applied in the center at x = 500 mm.
2. The deflection of the bar is measured with dial gauge at intervals of 100mm.
3. Take the readings of the two dynamometers and the dial-gauge at each time you relocate the applied load.

Note: The dynamometers experience spring excursion under load. In order to prevent measurement errors as a result of this additional deflection f, the results should be returned to their original position.

Part 3:

Deflection of cantilever beam:

1. Fasten the support pillar to the frame.
2. Clamp the bar to the support pillar.
3. Place the rider on the bar and lock in the required position.
4. Fasten the dial gauge to the frame with the holder in such a way that the tracer pin of the dial-gauge is touching the flattened part of the rider bolt.

5. Set the dial gauge to zero with the bar unloaded. To do so, adjust the holder and rotate the scale for precise adjustment.
6. Suspend the load weight, read the deflection on the dial gauge and record it.

Results and analysis:

1. Fill the experimental results at tables 1, 2 & 3.
2. Calculate the reaction forces and compare with experimental values (table 1).
3. Calculate the theoretical deflection and compare with the experimental values of simply supported beam (table 2).
4. Calculate the theoretical deflection and compare with the experimental values of cantilever beam (table 3).
5. Find percentage of error in each case compared to the theoretical ones.
6. Comment on your results and state specifically the source of error in each case.

Distance **x** from support **A** (mm)	Experimental		Theoretical		Percentage Error (%)	
	Reaction force **A** (N)	Reaction force **B** (N)	Reaction force **A** (N)	Reaction force **B** (N)	Reaction force **A**	Reaction force **B**
100						
200						
300						
400						
500 (Center)						

Table 1: Part 1, *Reaction forces.*

Distance **x** from support **A** (mm)	Deflection **W** (Experimental) (mm)	Deflection **W** (Theoretical) (mm)	Percentage Error (%)
100			
200			
300			
400			
500 (Center)			

Table 2: Part 2, simply supported beam deflection.

Length **L** from clamp (mm)	Deflection **W** (Experimental) (mm)	Deflection **W** (Theoretical) (mm)	Percentage Error (%)
200			
300			
400			

Table 3: Part 3, cantilever beam deflection.